COMPARING CRRES INTERNAL DISCHARGE MONITOR RESULTS WITH GROUND TESTS AND PUBLISHED GUIDELINES

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Abstract:

Various attempts have been made to reconcile the data from the CRRES IDM experiment with ground test results, with modeling and with guidelines. Based on recent testing supported by the NASA/MSFC SEE program, and other programs, it now becomes easier to reconcile the CRRES in-space data with typical ground test data. Recent test data will be described to show how it improves our understanding. Suggestions will be offered for how guidelines may be improved. Suggestions for guideline enhancements will focus on NASA-HDBK-4002 and NASA TP 2361.

1. Some modeling has predicted that the electric fields in the IDM samples should never have produced pulses because the electric fields should not exceed 1E5 V/cm. (Answer) But this modeling was based on resistivity values, taken from handbooks, that was much too low. New measurement methods using injection of electric fields with electron space charge find the correct values for sample resistivity are very high.

2. The distribution of pulse amplitude as seen on IDM was not like that seen in ground tests using multi-keV to MeV electron beams. The IDM pulses were small. (Answer) Recent tests find that the pulse rate is an indicator of the static electric field strength in the insulator. Small pulse rates indicate small field strength, of the order 1E5 V/cm. And when the field strength is small, the gas burst is small producing only small pulses. The ground tests produced higher internal electric fields.

3. The surface potentials developed on the IDM floating surfaces theoretically should have achieved large values and thereby force frequent pulsing, more frequent than actually observed on IDM. (Possible Answers) The radiation-induced coefficient of conductivity was not properly extrapolated to space-like low dose rate. Electric field enhancement causes secondary electron emission to be higher than normal.

4. The pulse rate by floating metal surfaces on IDM was less than that of simple floating dielectric surfaces. The twisted shielded pair cable with one floating wire never pulsed on IDM. Yet guidelines point to floating metals as particularly threatening. (Answers) A review of ground test results found frequent pulsing by a floating metal to occur on only a few of the floating metal samples. The edge of a grounded metal on a dielectric is a better pulse generator than is that of a floating metal. The physics concerning floating metal is not well understood. It may be that electric field strength is the important parameter so that metal interfaces become important only as they influence electric field in the insulator sample.

5. Pulse rate on IDM is a function of time in space. It was previously known that PTFE becomes progressively more conductive due to radiation. The IDM found fewer pulses in PTFE after accumulating a few months of dose, in agreement with the prior knowledge where more conductivity reduces electric field, and thereby reduces pulsing. But FR4 produced more pulses after months of space exposure. (Answer) Recent tests with FR4 find it does not pulse easily at moderate field strength (1E5 V/cm) until substantial dose is accumulated. In space, PTFE pulsed for many days before FR4 began to pulse, and then FR4 was a relatively slow pulser for months relative to PTFE. After six months in space, FR4 pulsed frequently. Ionizing dose may improve the ability of FR4 to produce a discharge tree with its associated burst of gas.

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